The effect of the bias electric field on the dielectric and pyroelectric properties of single crystals and ceramics of Pb_2ScNbO_6 relaxor ferroelectric

S.I. Raevskaya[1], A.G. Lutokhin[1], Y.N. Zakharov[1], I.P. Raevski[1], A.A. Gusev[2], V.P. Isupov[2], V.V. Titov[1], M.A. Malitskaya[1], G.R. Li[3]

[1]*Research Institute of Physics and Faculty of Physics, Southern Federal University, 344090, Rostov-on-Don, Russia*
e-mail: igorraevsky@gmail.com
[2]*Institute of Solid State Chemistry and Mechanochemistry SB RAS, 630128 , Novosibirsk, Russia*
[3]*Shanghai Institute of Ceramics, Chinese Academy of Sciences, 200050, Shanghai, China*

Relaxor ferroelectrics are now in the focus of both material science, and physics of the inhomogeneous media as they exhibit giant dielectric, electrostrictive, pyroelectric, and piezoelectric responses, while the origin of these remarkable properties is not fully understood yet. Of special interest are 1:1 ternary perovskites of the $Pb_2B^{3+}B^{5+}O_6$ type (B^{3+} - Sc, In, Yb and B^{5+} - Nb, Ta) because one can change their properties from a usual ferroelectric or antiferroelectric with a sharp phase transition to a relaxor ferroelectric, characterized by a diffuse and frequency-dependent maximum of the dielectric permittivity ε, by varying the ordering degree S of B^{3+} and B^{5+} cations. As the S values depend on the preparation conditions there is a large scattering of the data concerning the properties of $Pb_2B^{3+}B^{5+}O_6$ perovskites. In the present work we studied the effect of the bias electric field on the dielectric and pyroelectric properties of both single crystals and ceramics of the canonic relaxor Pb_2ScNbO_6 (PSN) obtained by different methods. Single crystals were grown by the spontaneous crystallization from the flux at different cooling rates. Ceramics was fabricated using a one-step sintering either of the mixture of the starting oxides with 2 wt.% of Li_2CO_3 addition, or of the PSN powder obtained by mechanochemical synthesis using a high-energy planetary-centrifugal mill AGO-2.

Dielectric measurements have shown that all the samples studied exhibit a diffused ε(T) maximum. Both the temperature $T_{m\varepsilon}$ of this maximum (360-370 K) and a substantial relaxor-like frequency shift of $T_{m\varepsilon}$ are typical of disordered PSN. However a sharp and frequency-independent step is observed in the ε(T) curves at 340-350 K, which seems to be due to the presence of highly-ordered regions in the samples. Similar to a 1:2 textbook relaxor $Pb_3MgNb_2O_9$ (PMN) and its solid solutions with $PbTiO_3$ (PT) [1] $T_{m\varepsilon}$ depends on the bias field strength E only above some threshold E value. At zero field the maximum of the dynamic pyroelectric coefficient γ dependence on T is observed in the vicinity of the Vogel-Fulcher temperature. At rather small bias fields, this maximum shifts to the position of the supposed critical point (which is in the vicinity of $T_{m\varepsilon}$) and grows in magnitude. The γ(T) maximum increases up to the field corresponding to the critical point in the E-T phase diagram (it can be roughly estimated from the inflexion in the $T_{m\varepsilon}$(E) dependence) and decreases at higher fields. These data are similar to those obtained for PMN-PT crystals with a small PT content [1] as well as for single crystals of the uniaxial relaxor $Sr_{0.75}Ba_{0.25}Nb_2O_6$ [2] and support the presence of a critical point and a quasicritical behavior of pyroelectric coefficient in PSN ceramics. Dielectric, pyroelectric and piezoelectric properties near critical points are compared and discussed for 1:1 and 1:2 relaxor ferroelectrics.

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1. S.I. Raevskaya, Yu.N. Zakharov, A.G. Lutokhin, et al., *Appl. Phys. Lett*. **93**, 042903 (2008).
2. S.I. Raevskaya, A.G. Lutokhin, A.M. Pugachev, et al., *Ferroelectrics* **440**, 59 (2012).